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Oxygen Management

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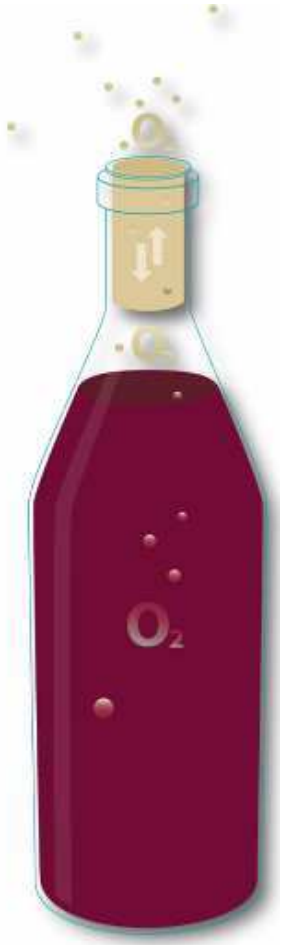
Introduction – Oxygen in wine

- Before bottling
- At bottling
  - Dissolved in wine
  - Headspace oxygen
  - Closure in situ
- Post bottling – closure oxygen transmission rate (OTR)



Bottle image provided by Stéphane Vidal, Nomacorc

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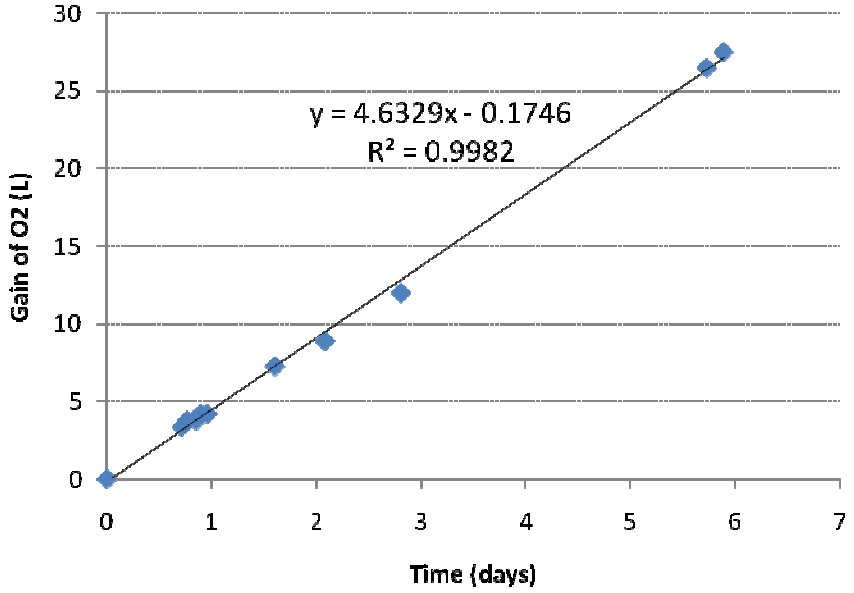
Ullage management

How much oxygen enters a tank?

- AWRI measurement on 760 L tank, with standard lid and breather valve
- Tank inerted with dry ice to < 0.2 % O_2



- Over 4 L of oxygen ingress per day!!

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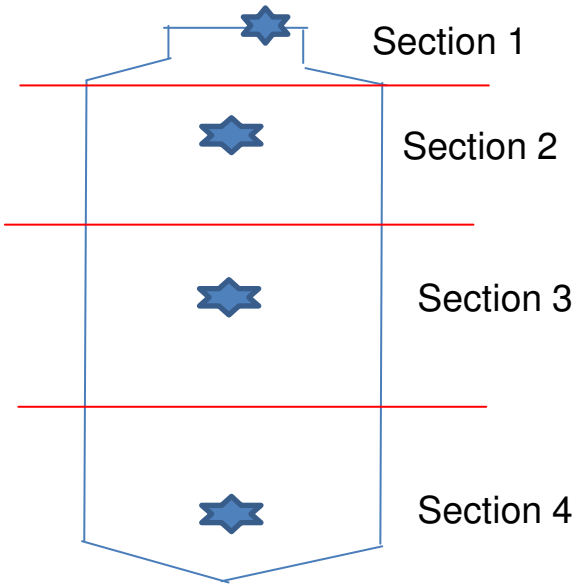
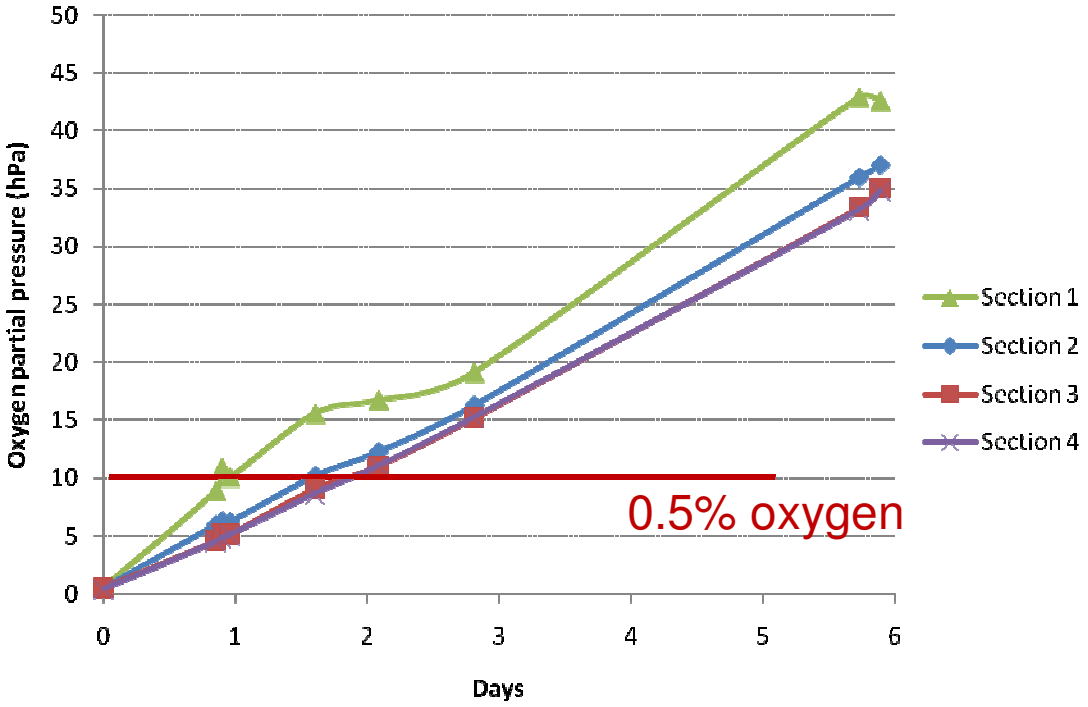
Theoretical oxygen exposure

- 4 L (~5g) of oxygen ingress per day equates to
  - 0.5mg/L/day - 10kL
  - 0.025mg/L/day - 200kL
- Thermal expansion – 0.15mg/L every refrigeration event
- 30s lid opening – ~28L per event
  - 3.5mg/L/opening - 10kL
  - 0.175mg/L/opening - 200kL

Oxygen diffusion through CO_2





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Bottling oxygen management

- Current oxygen management regimes:
  - In the bottling tank; and
  - Dissolved in the packaged wine

- This only tells part of the story, even when shaking protocols are used
- Total package oxygen is the critical performance parameter

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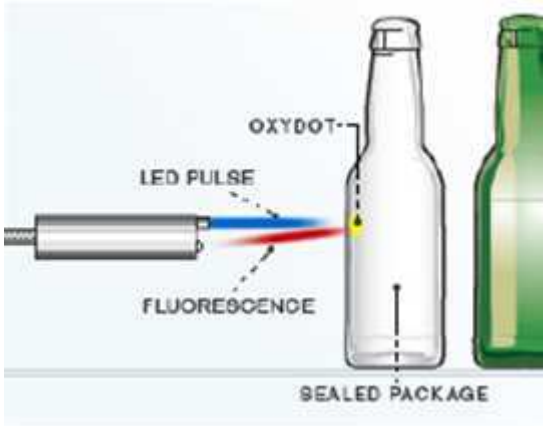
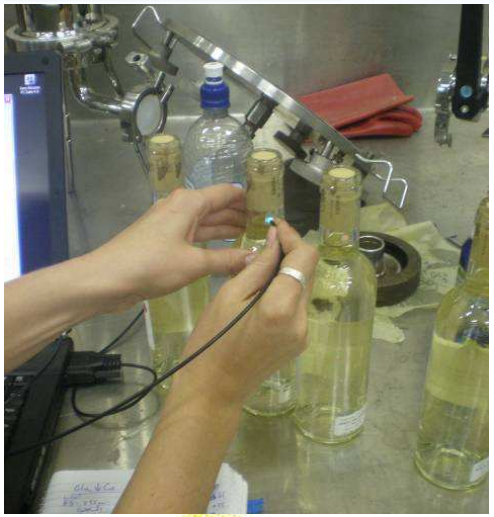
Total package oxygen measurement

- Quantifies dissolved oxygen AND the gaseous oxygen in the headspace
  - Reference method: NomaSense optical sensing technology
  - Oxygen sensitive spots are glued into the bottles
  - The oxygen spot is illuminated with a blue light, and it then emits a signal intensity proportional to the oxygen concentration





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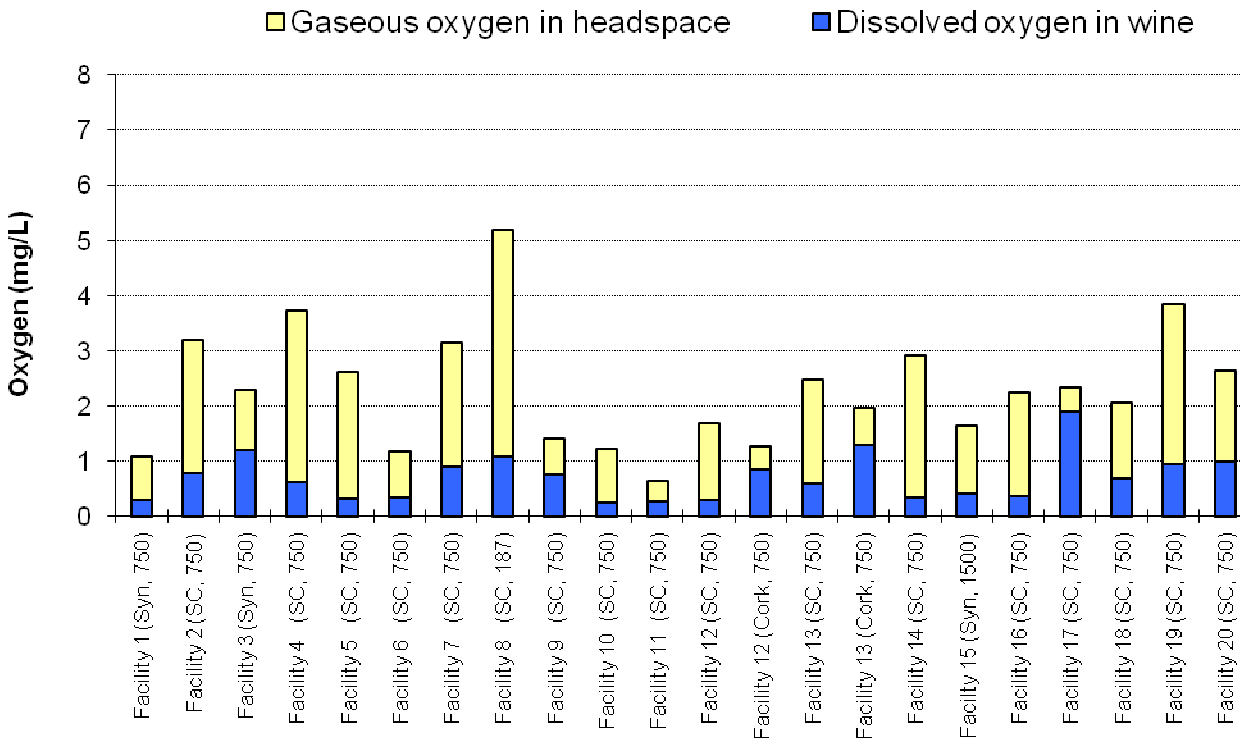

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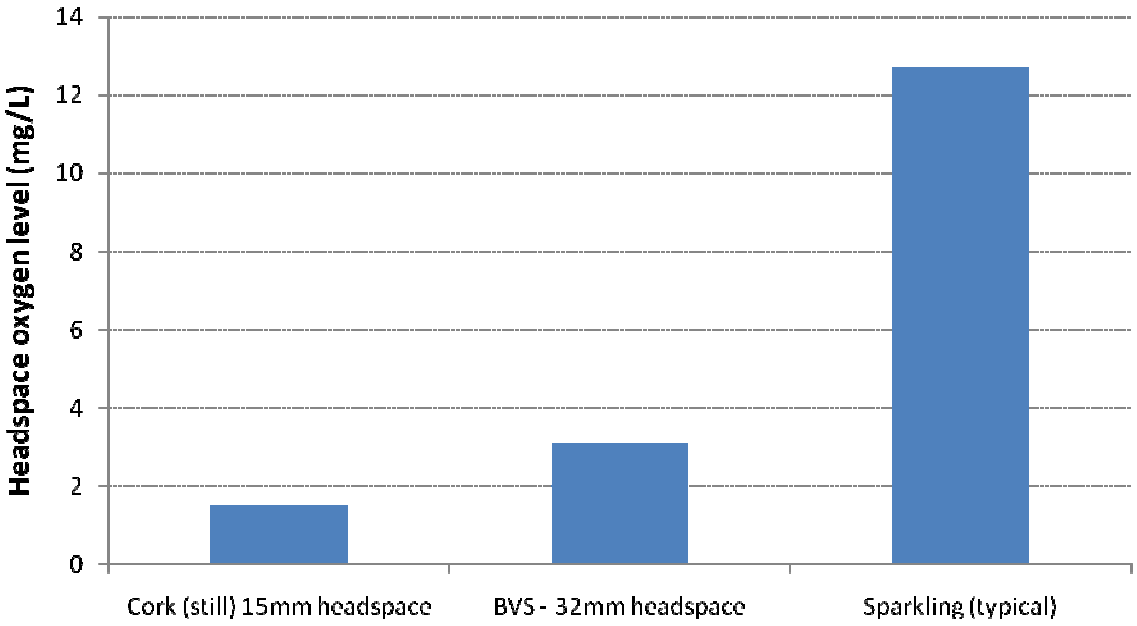
Potential headspace oxygen levels



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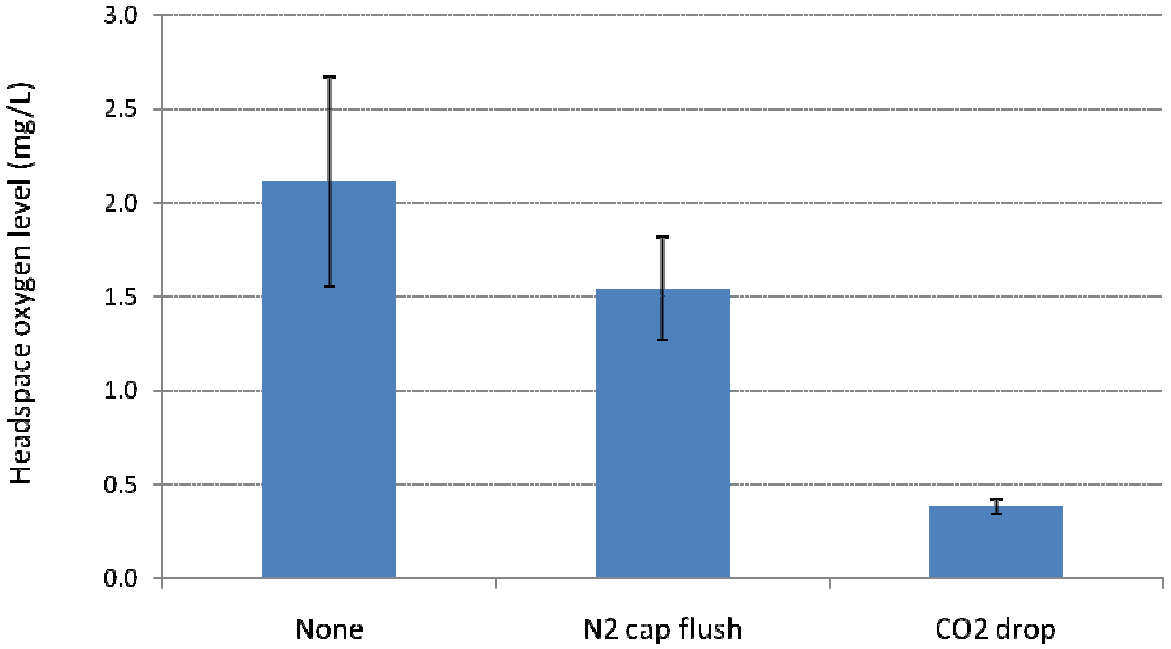
TPO reduction strategies

- Reduce headspace volume
  - May not be feasible
- Reduce headspace oxygen concentration
  - Optimising line configuration – minimise distance from filler to corker
  - Filling warmer
  - Inert gas or cryogenic dosing
  - Beer strategies (fobbing)

Headspace treatment

Lab scale trial investigating Zork SPK headspace treatments



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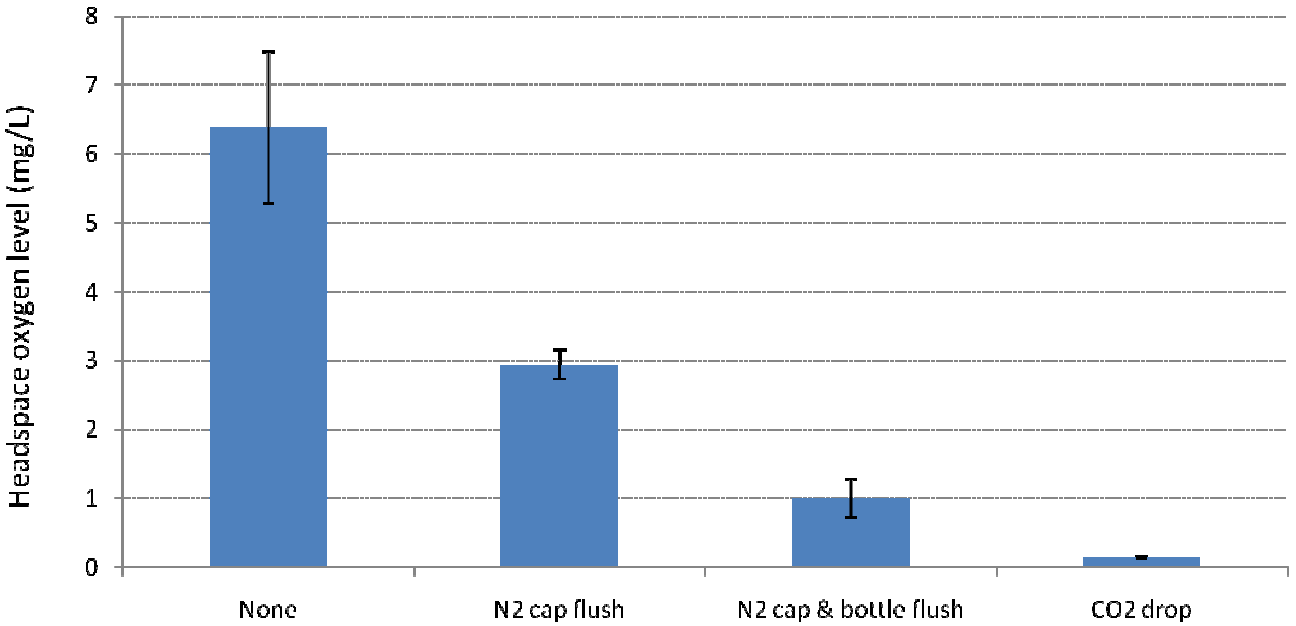
Headspace treatment

Lab scale trial investigating Zork SPK headspace treatments

- repeated 5 minutes after initial trial



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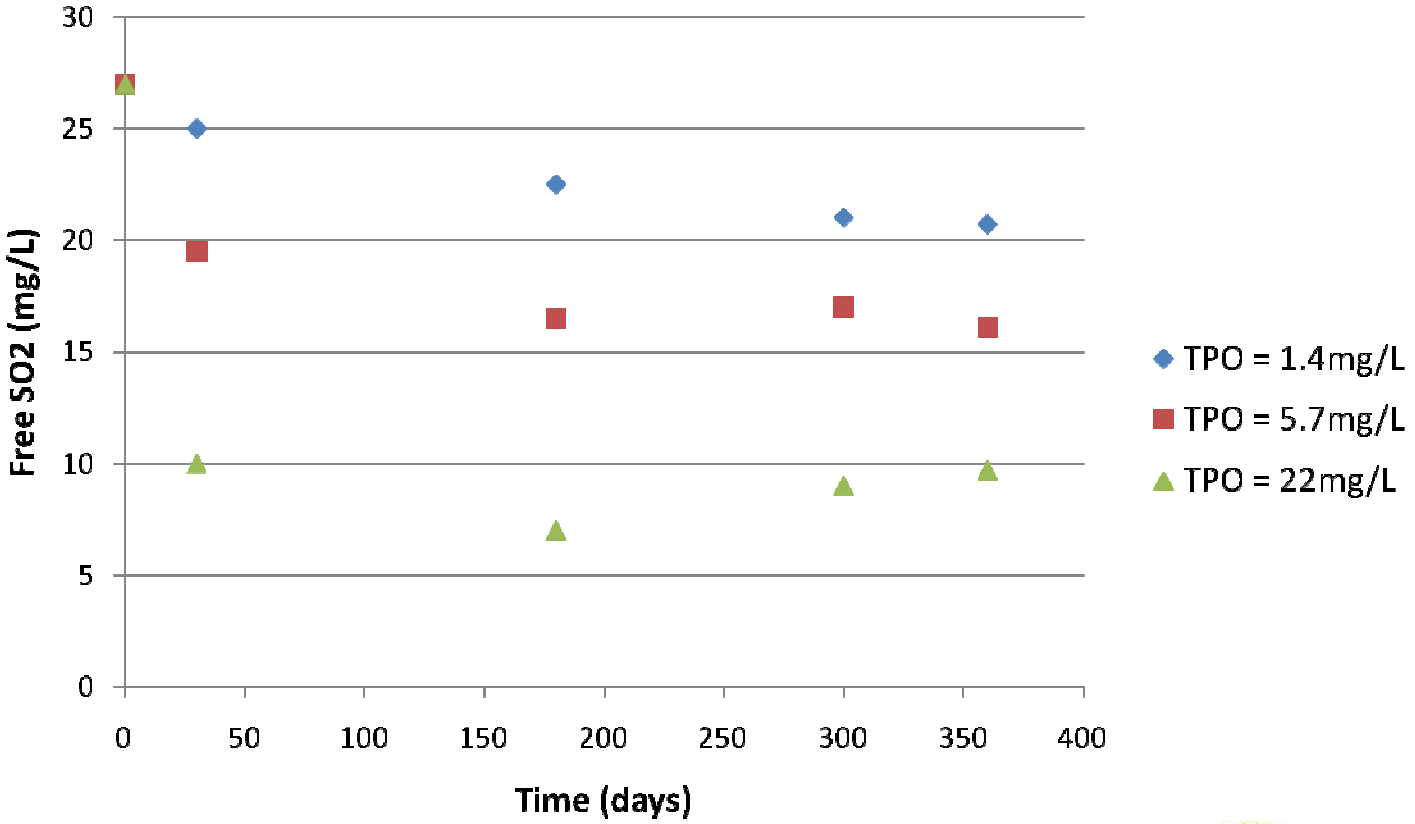
Impacts – Quality and shelf life

- Absolute quality impacts are matrix dependant
  - Additional work required to fully understand impact of differing TPO levels
- Bottle – bottle variability
  - Resulting from online collisions and/or stoppages
- Shelf life is unquestionable impacted

Impact of headspace oxygen

Red wine closure trial, 12 months post-bottling



Kwiatkowski et al 2007, AJGWR

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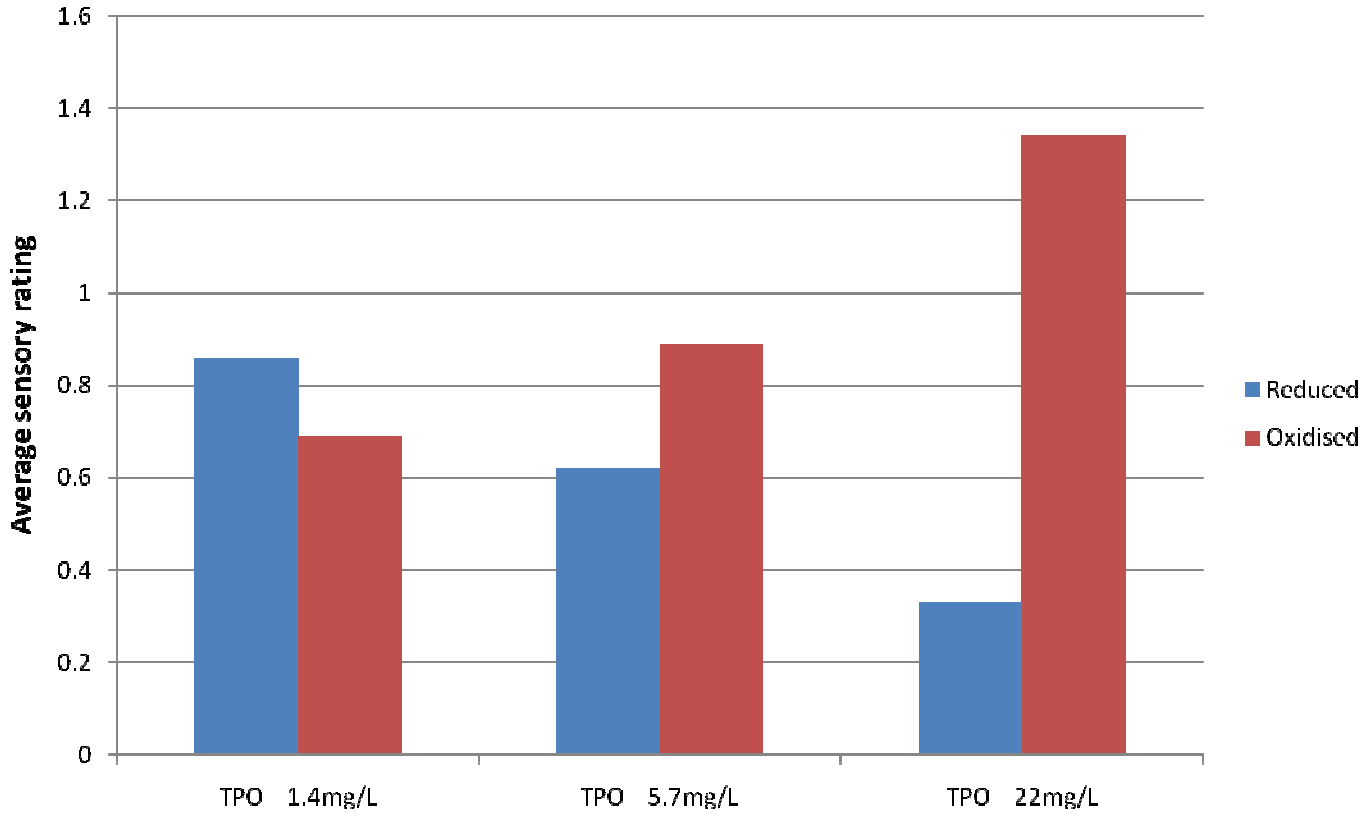

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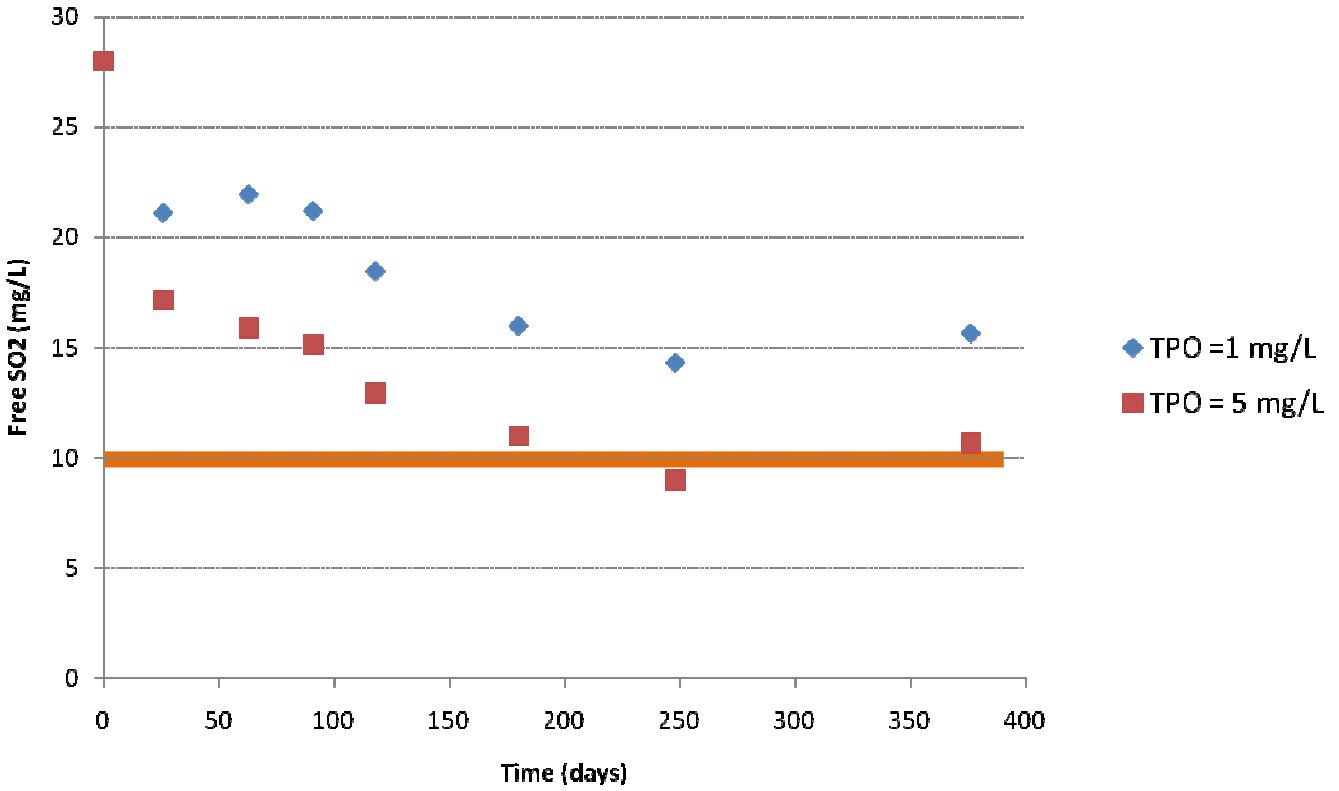
Impact of headspace oxygen

White wine controlled TPO dosing trial



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Impact of headspace oxygen

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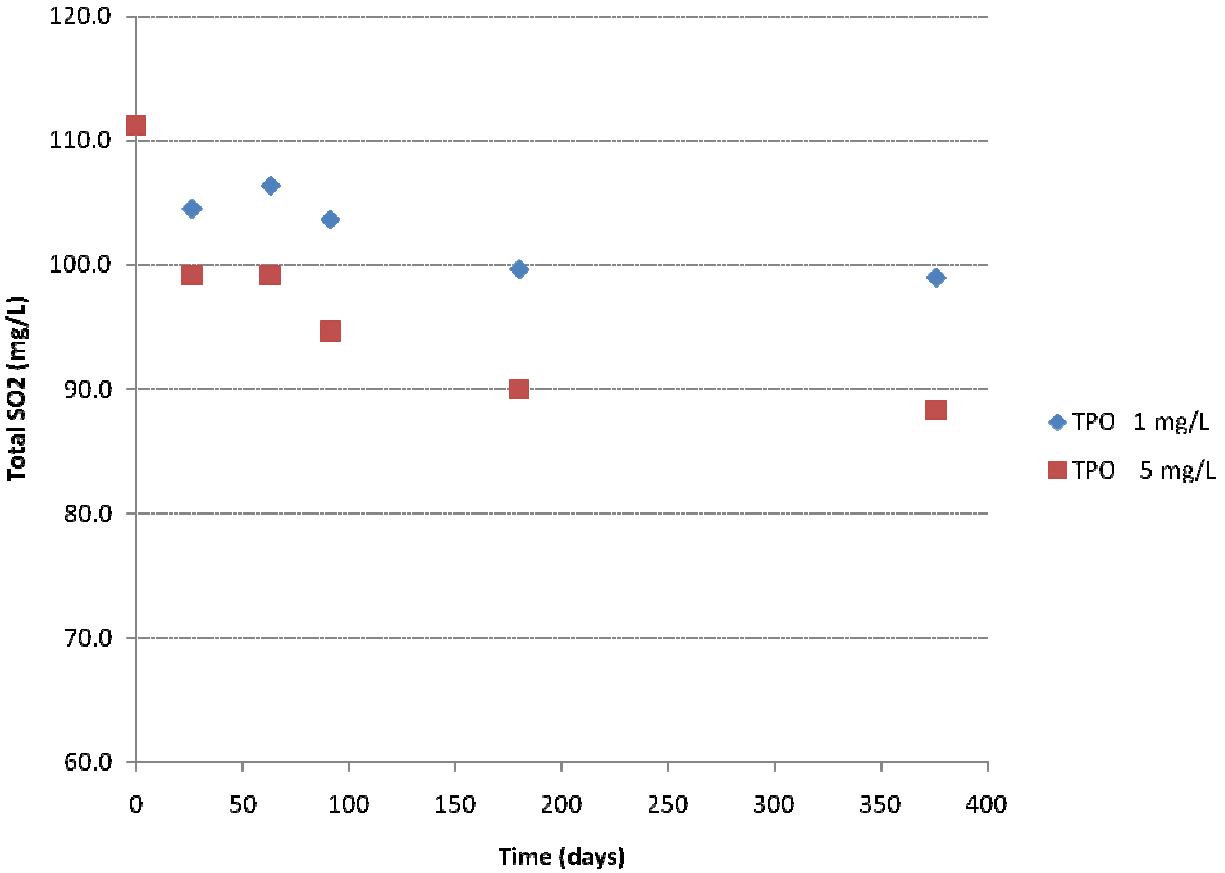

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TPO measurement

- Still wines
  - Shaken bottle method to measure DO
  - Use AWRI calculator to convert DO value to TPO
  - Indirect measurement using oxy-luminescence (fluorescent quenching) technologies
- Sparkling wines
  - Bottle shaking may still be feasible
  - Off-the-shelf TPO analysers used by breweries
  - Customised low cost solutions using fluorescent quenching technology

http://www.hach.com

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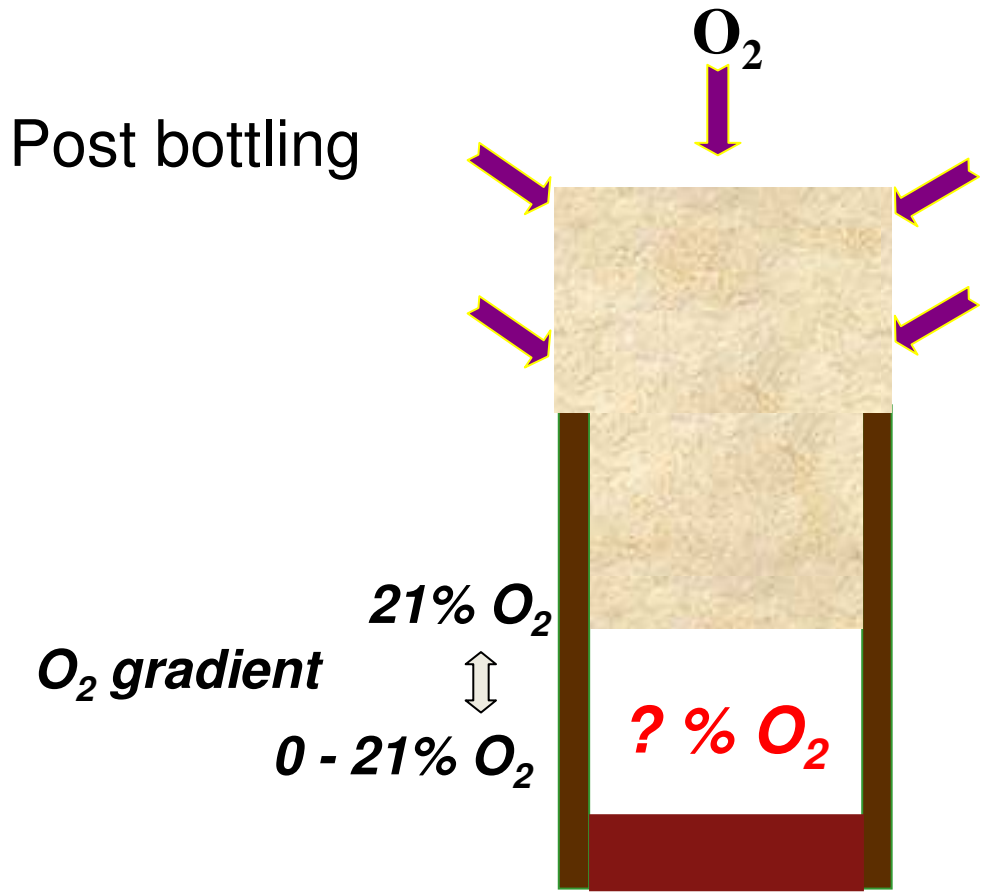
Closure Oxygen Transmission Rate

- Driven by concentration gradient and diffusion coefficient



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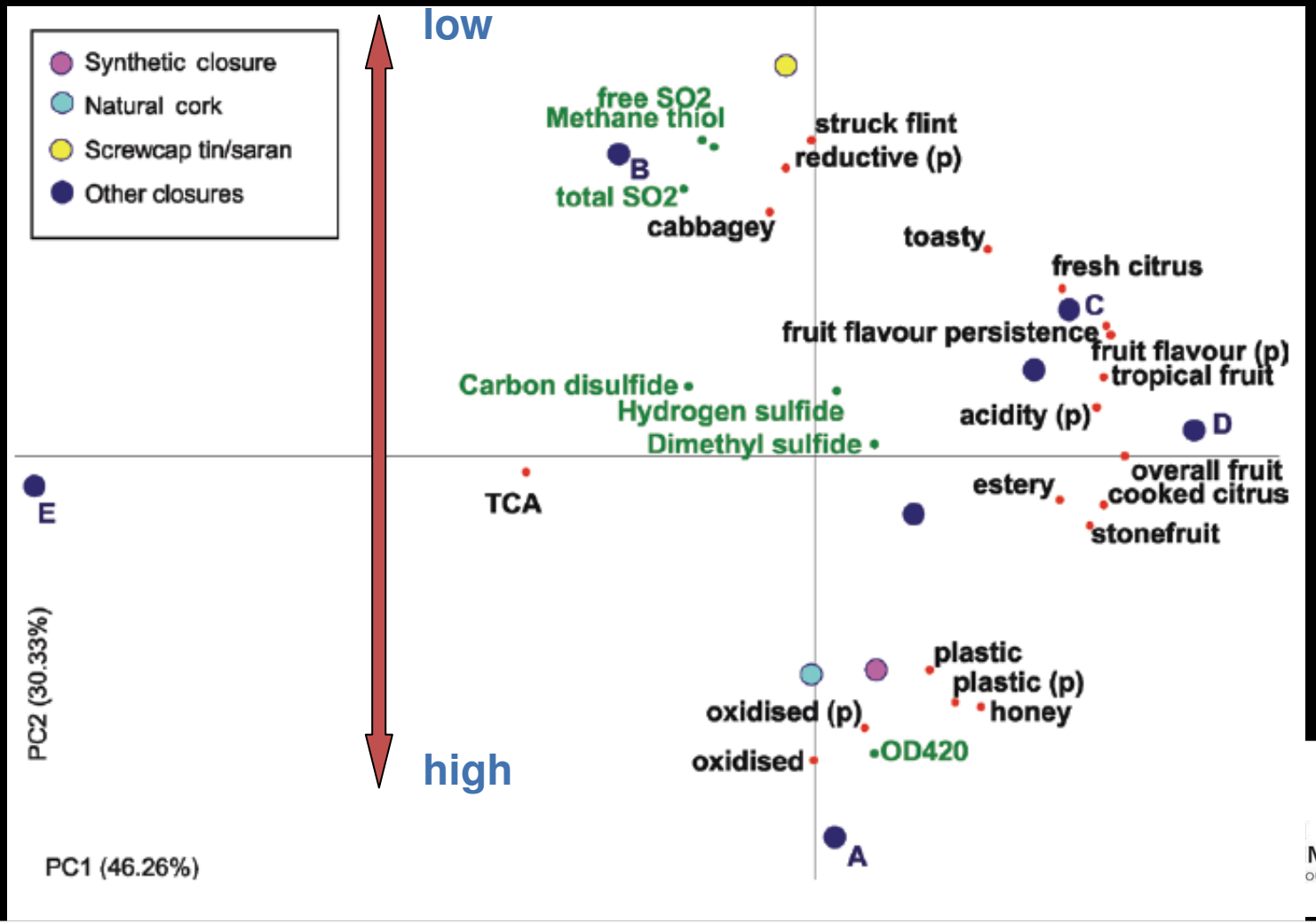

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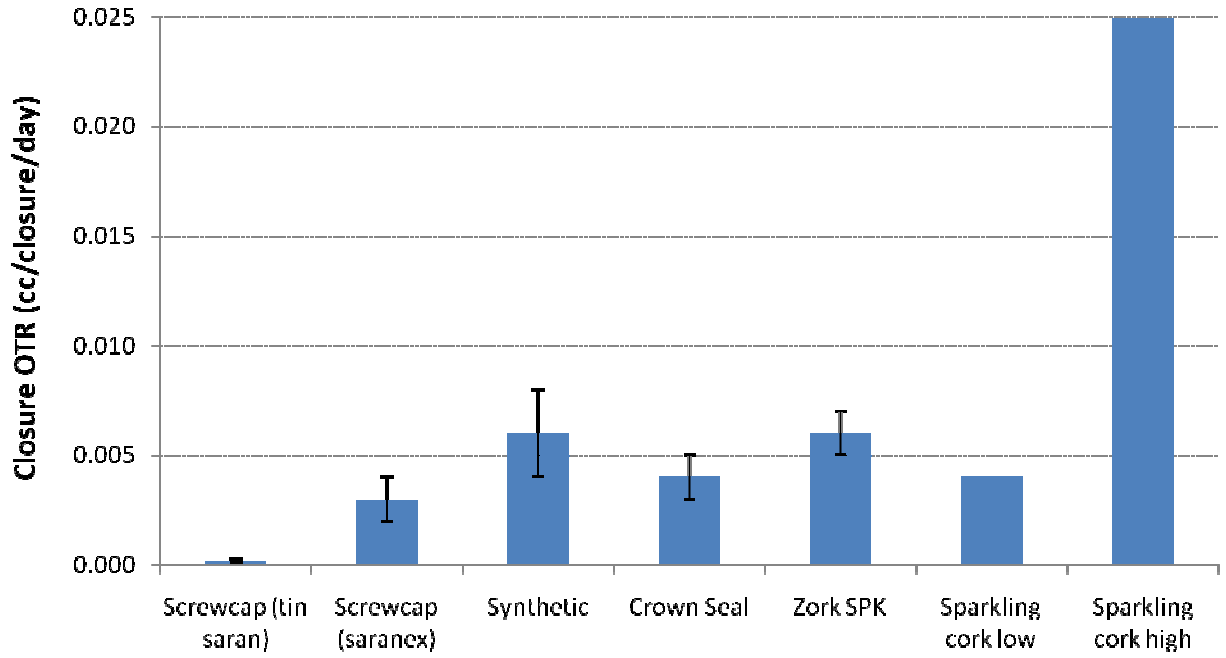
Typical Closure OTR's



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Summary

- Robust ullage management is key when storing wine for extended periods
- Measuring DO to control bottling operations is largely irrelevant – TPO it the key parameter
- Sparkling wines face even greater scope than still wines for bottling related quality and shelf life impacts
- Relatively simple techniques can be used to ensure the headspace is at an acceptable oxygen concentration
- Closure choice is a major influence it determining the ultimate wine style and product shelf life